Naval Research Laboratory
Washington, DC 20375-5320

NRL/MR/6180--01-8576

ex-*USS Shadwell* (LSD-15)—The Navy's Full-Scale Damage Control RDT&E Test Facility

Frederick W. Williams
Xuan Nguyen
CWO4 James Buchanan

Navy Technology Center for Safety and Survivability
Chemistry Division

John P. Farley

Geo-Centers, Inc., Lanham, MD

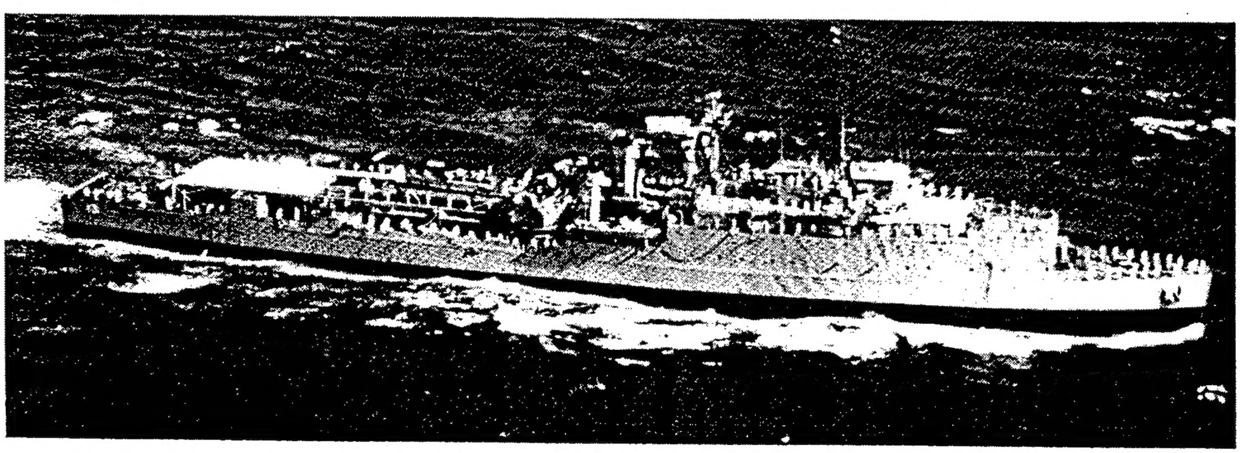
Joseph L. Scheffey
Jennifer T. Wong
Hung V. Pham

Hughes Associates, Inc., Baltimore, MD

Terry A. Toomey

Consultant

August 24, 2001



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (*Leave Blank*)

2. REPORT DATE

August 24, 2001

3. REPORT TYPE AND DATES COVERED

Interim Report 2000

4. TITLE AND SUBTITLE

ex-*USS Shadwell* (LSD-15) — The Navy's Full-Scale Damage Control RDT&E Test Facility

5. FUNDING NUMBERS

PE - 063508N

6. AUTHOR(S)

Frederick W. Williams, Xuan Nguyen, CWO4 James Buchanan, John P. Farley,*
Joseph L. Schaffey,† Jennifer T. Wong,† Hung V. Phan,† and Terry A. Tommey‡

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Naval Research Laboratory, Code 6180
4555 Overlook Avenue, SW
Washington, DC 20375-5320

8. PERFORMING ORGANIZATION REPORT NUMBER

NRL/MR/6180--01-8576

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Office of Naval Research
800 North Quincy Street
Arlington, VA 22217-5660

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

*GEO-Centers, Inc., 4640 Forbes Boulevard, Suite 130, Lanham, MD 20707
†Hughes Associates, 3610 Commerce Drive, Baltimore, MD 21227
‡16676 Pinewood Trail Road NE, Newark, OH 43055

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

This report reviews the capabilities of the Navy's full-scale damage control RDT&E platform, ex-*USS Shadwell* (LSD-15). The ex-*USS Shadwell* serves as the ultimate test platform in the development of fire fighting agents, DC systems, predictive models and technology stemming from basic and theoretical concepts developed through naval research. As a complete Navy platform, it enables consolidation of research developments from laboratories, system comands, industry and the fleet to assess technology and DC doctrine in a realistic shipboard damage environment. Thus, the ex-*USS Shadwell* provides a very versatile and realistic test bed for finalizing the fruits of research and development that are on their way to the fleet.

14. SUBJECT TERMS

ex-*USS Shadwell*	Damage control	Flooding
Fire fighting	Ship fires	

15. NUMBER OF PAGES

37

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std 239-18
298-102

Contents

List of Acronyms

ADC	Advanced Damage Countermeasures
AFFF	Aqueous Film Forming Foam
AMR	Auxiliary Machinery Room
CIC	Combat Information Center
CSMC	Combat System Maintenance Central
COTS	Commercial-Off-The-Self
CNO	Chief of Naval Operations
CPS	Collective Protection System
DC	Damage Control
DCAMS	Damage Control Asset Management System
DC-ARM	Damage Control – Automation for Reduced Manning
DCC	Damage Control Central
DCQ	Damage Control Quarters
DCRS	Damage Control Repair Station
DCS	Damage Control System
EOCS	Engineering Operating Control Station
EWFD	Early Warning Fire Detector
FDE	Fleet Doctrine Evaluation
FNC	Future Naval Capabilities
EOCS	Engineering Operating Control Station
EWFD	Early Warning Fire Detector
FR	Frame
FY	Fiscal Year
GRP	Glass Reinforced Plastic
HPAC	High Pressure Air Compressor
ISFE	Integrated Survivability Fleet Evaluations
LAN	Local Area Network
LP	Limited Protection
LPAC	Low Pressure Air Compressor
LPES	Limited Protection Exhaust System
LPSS	Limited Protection Supply System
MMR	Main Machinery Room
NRL	Naval Research Laboratory
NSTM	Naval Ships' Technical Manual
NSWC	Naval Surface Warfare Center
NAVSEA	Naval Sea Systems Command
OBA	Oxygen Breathing Apparatus
ODM	Optical Density Meter
ONR	Office of Naval Research
RDT&E	Research, Development, Test and Evaluation
SCBA	Self-Contained Breathing Apparatus
SCS	Supervisory Control System
SES	Smoke Ejection System
TP	Total Protection
TPES	Total Protection Exhaust System
TPSS	Total Protection Supply System
USCG	United States Coast Guard

ex-*USS Shadwell* (LSD-15) — The Navy's Full-Scale Damage Control RDT&E Test Facility

1.0 BACKGROUND

The purpose of this report is to provide information about the Navy's full-scale Damage Control RDT&E test facility, ex-*USS Shadwell* (LSD-15). The report is meant to be a living document that will periodically review the test facility's capabilities, and on-going and planned research initiatives.

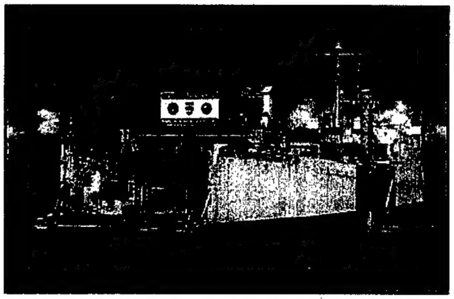
The recent history of the ex-*USS Shadwell* began with a Joint Research Agreement that was developed and signed by USCG, NAVSEA and ONR on 23 September 1985 [Appendix A]. The objective of the Joint Research Agreement was to increase the effectiveness of the USCG and USN research programs in fire protection and expand the USCG Fire and Safety Test Detachment (F&STD) in Mobile, Alabama to include a test site for the U.S. Navy's test ship, ex-*USS Shadwell.*

The coordinator and custodian for the ex-*USS Shadwell* is the Navy Technology Center for Safety and Survivability at NRL. The Technical Director of the ex-*USS Shadwell* is Dr. Frederick W. Williams, NRL Code 6180, (202) 767-2476, e-mail: fwilliam@ccs.nrl.navy.mil. ONR point of contact is Mr. James Gagorik, Code 334, (703) 696-4719. NAVSEA points of contact include Mr. Dennis McCrory, Code 05L4, (202) 781-3647 and Mr. Brian Smale, Code PMS 500, (703) 602-6453. A compilation of all technical reports generated as a result of the ex-*USS Shadwell* can be found on the web site: http://www.chemistry.nrl.navy.mil/6180/. This listing is dynamic and is updated regularly.

2.0 INTRODUCTION

The ex-*USS Shadwell* is a major facility in an extensive program at ONR and NAVSEA for the protection of life and property, under the auspices of NRL's Navy Technology Center for Safety and Survivability. As a complete Navy platform, it allows the application and consolidation of research developments from the Laboratories, System Commands, CNO, the Fleet and industry, to give an integrated picture of the interactions of man, equipment, materials, doctrine and systems in a realistic shipboard damage environment (see Fig. 1). The ex-*USS Shadwell* experiments also provides a unique opportunity to identify new problems that have not been previously considered and enable a method to discover and develop effective solutions.

Manuscript approved May 31, 2001.



RDT&E of Fleet issues/concerns on the ex-USS *Shadwell*

Evaluation of hardware/software concepts and experiments with users. (eg. System Commands, OPNAV Staff, Navy Warfare Centers, Navy Laboratories, Fleet commands and training commands

Fig. 1 — Full-Scale DC Technology and Doctrine Development

Programmatically, the ex-*USS Shadwell* serves as the ultimate test platform in the development of fire fighting agents, DC systems, predictive models and technology stemming from basic and theoretical concepts developed through naval research. The ex-*USS Shadwell* also serves as realistic shipboard test platform for endeavors other than DC that evolve from research and development in other disciplines, such as coatings, insulation, working fluids, cleaners and communications.

Thus, the ex-*USS Shadwell* is a very versatile and realistic test bed for finalizing the fruits of research and development that are on their way to the Fleet – to minimize, or even prevent, the loss of mission capability as a result of wartime action or readiness in the case of peacetime misadventure.

3.0 CAPABILITIES

The overall capabilities of the ex-*USS Shadwell* are organized into various categories; however, for the purpose of this report, they are divided into five facility functions. These facility functions include: Test Areas, DC Systems, Instrumentation, ex-*Shadwell* LAN and Support Services.

3.1 Test Areas

There are currently four primary test areas on board the ex-*USS Shadwell* for conducting full-scale damage control RDT&E studies. These test areas include:

- the Passive Fire Test Area,
- the Forward Surface Ship Test Area,

- the Machinery Space Test Area, and
- the Submarine Test Area

3.1.1 Passive Fire Test Area

The Passive Fire Test Area is located on the 01 Level of the ex-*USS Shadwell,* FR 15 to FR 29. This area was developed and has been used by the Passive Fire Program (PFP) (see section 4.1). Figure 2 shows a drawing of the test area with the hood calorimeter, which is used for heat release measurements [1]. The hood is used to collect all fire products and exhaust to the calorimeter stack, which is instrumented to provide gas analyses, flow and smoke measurements.

3.1.2 Forward Surface Ship Test Area

The Forward Surface Ship Fire Test Area is located between FR 9 to FR 36 on the main through 5th decks (i.e., hold level). It is currently configured to simulate the DDG 51 platform as closely as possible, given the ex-*Shadwell* geometry and resources available. Figures 3 to 7 provide an overview of the test area and compartment designations. Table 1 provides a comparison between the primary test compartment locations on the DDG 51 Class ships and the ex-*Shadwell.*

Table 1. Space Designations for DDG 51 Class Ship and ex-*USS Shadwell*

Space Designation	DDG 51 Location	Ex-*Shadwell* Location
CSMC/ Repair 8	01 Level	Main Deck (FR 15 – 23)
CPO Living Space	Main Deck	2nd Deck (FR 15-18)
CIC	Main Deck	2nd Deck (FR 18 – 22)
Combat Systems Office	Main Deck	2nd Deck (FR 22-29, port side)
Crew Living	1st Platform	3rd Deck (FR 15 – 18)
Comm Center	1st Platform	3rd Deck (FR 18 – 22, with dog-leg on port side to FR 24)
Radio Transmitter Room	1st Platform	3rd Deck (FR 22 – 24, stbd side)
Tomahawk Equip. Room	1st Platform	3rd Deck (FR 22 – 27, port side)
Engineering Storeroom	1st Platform	3rd Deck (FR 24 – 29)
AMR No. 1	2nd Platform/Hold Level	4th Deck/ Hold Level (FR 22 –29)
MMR No. 1	2nd Platform/Hold Level	4th Deck/ Hold Level (FR 29 – 36)

3.1.3 Machinery Space Test Area

The Machinery Space Test compartment occupies the area between FR 22 and 29, at the hold and 4th deck (Fig. 8). The approximate dimensions of the space are 8.5 m (28 ft) long from FR 22 – FR 29, 6 m (20 ft) high from the keel to 3rd deck and 8.4 m (27.75 ft) wide (port and starboard) at FR 29 narrowing to 7 m (22.96 ft) at FR 22. The

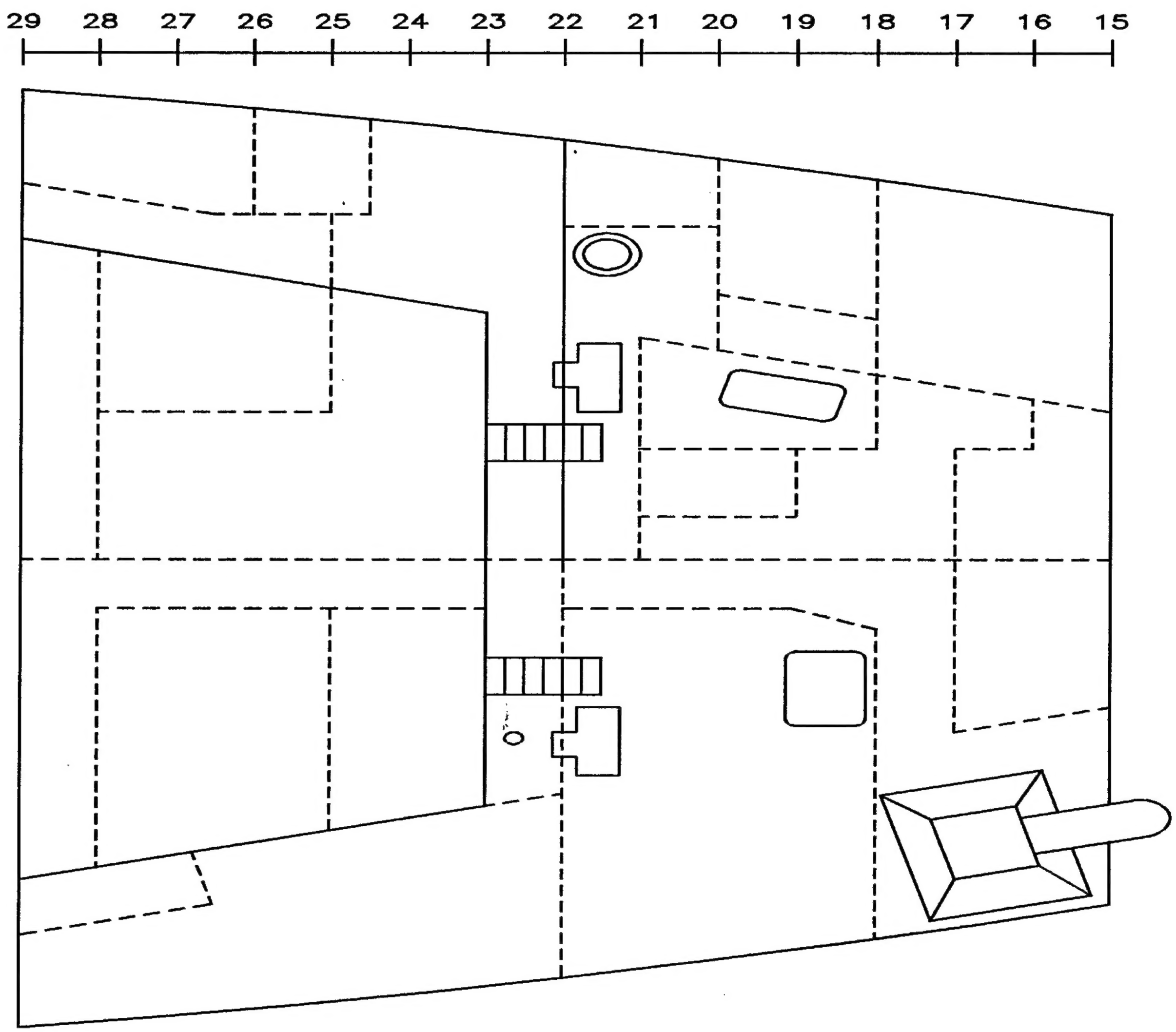


Fig. 2 - Plan view of Passive Fire Test Area

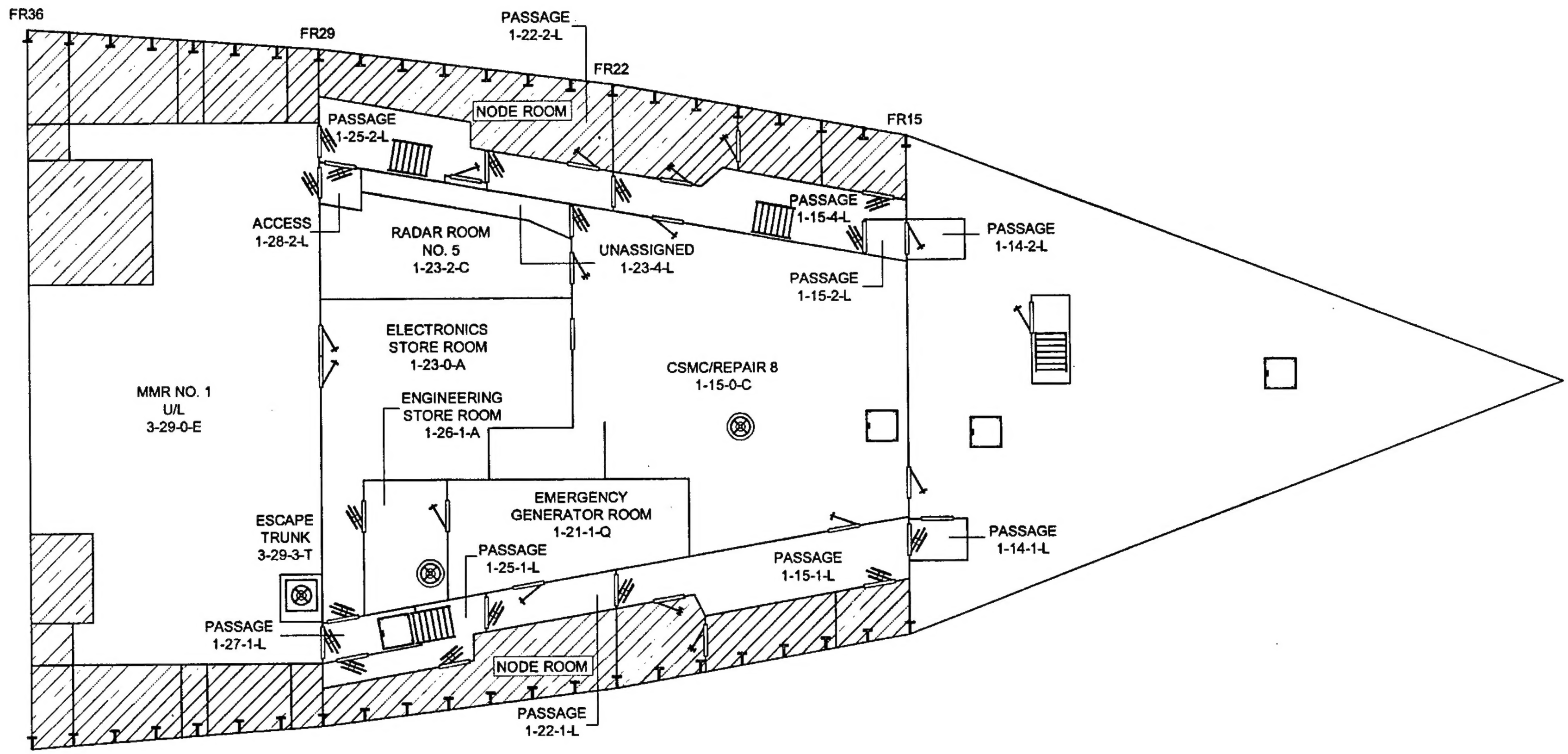


Fig. 3 - Layout of the main deck

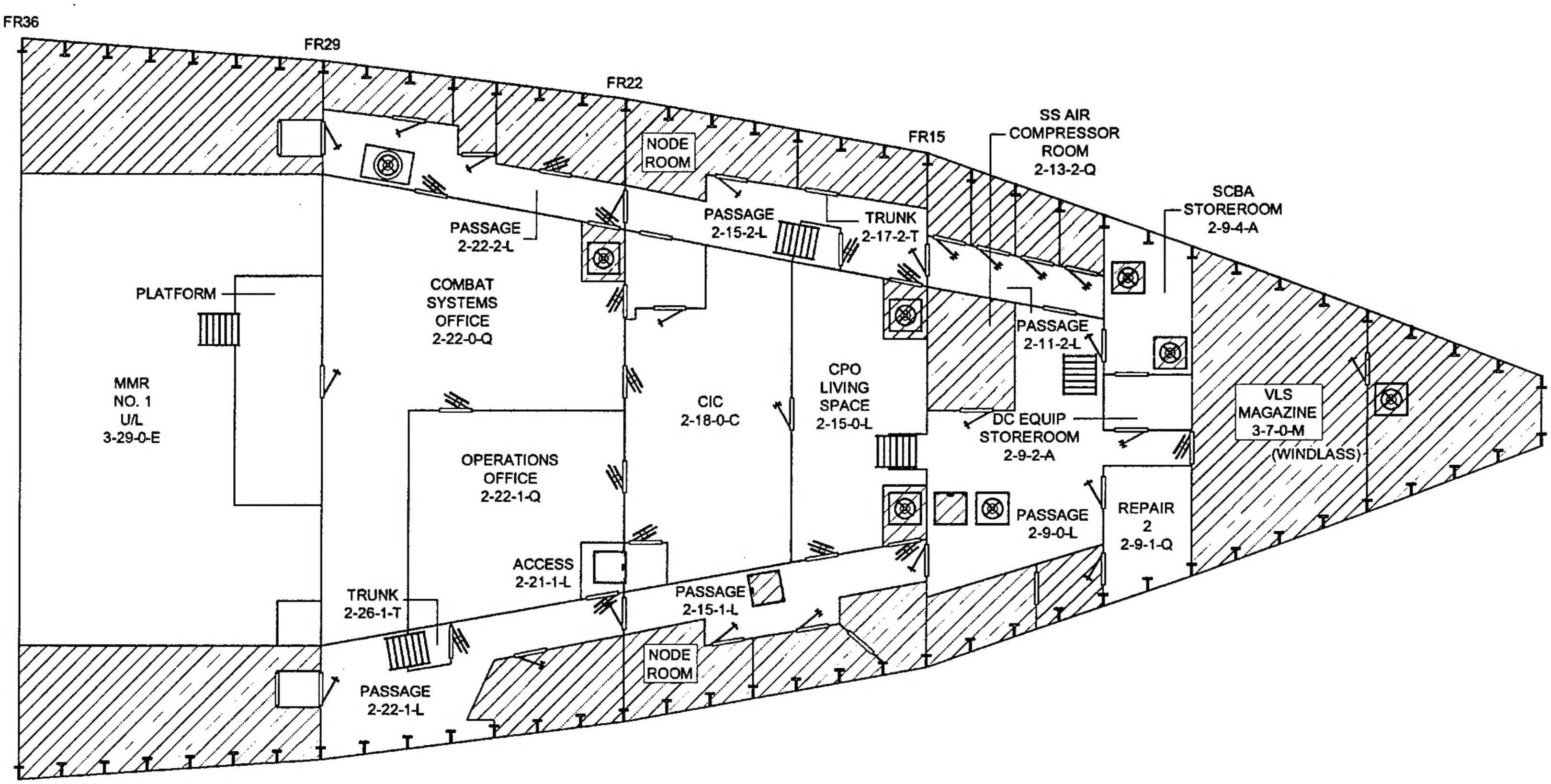


Fig. 4 - Layout of the second deck

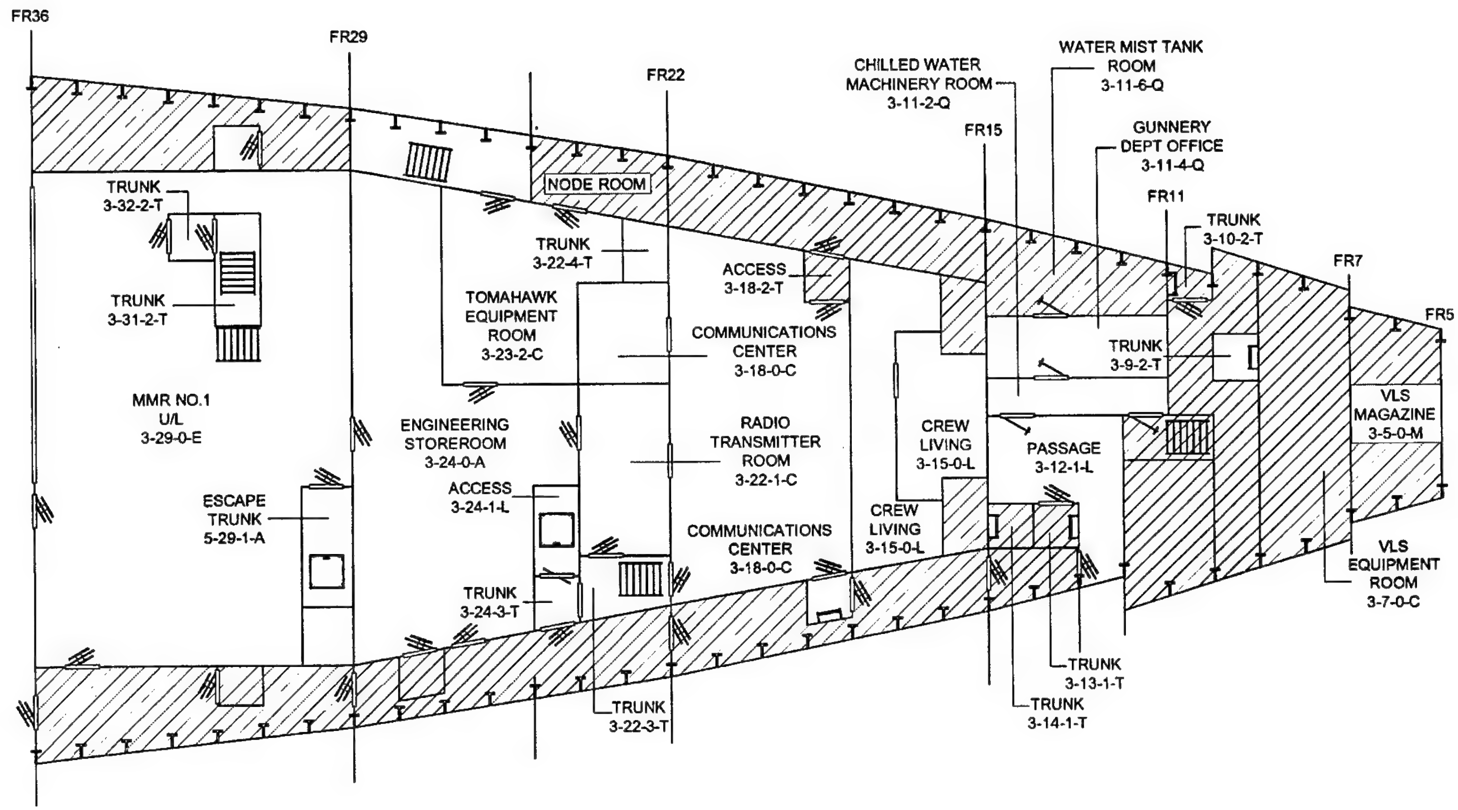


Fig. 5 - Layout of the third deck

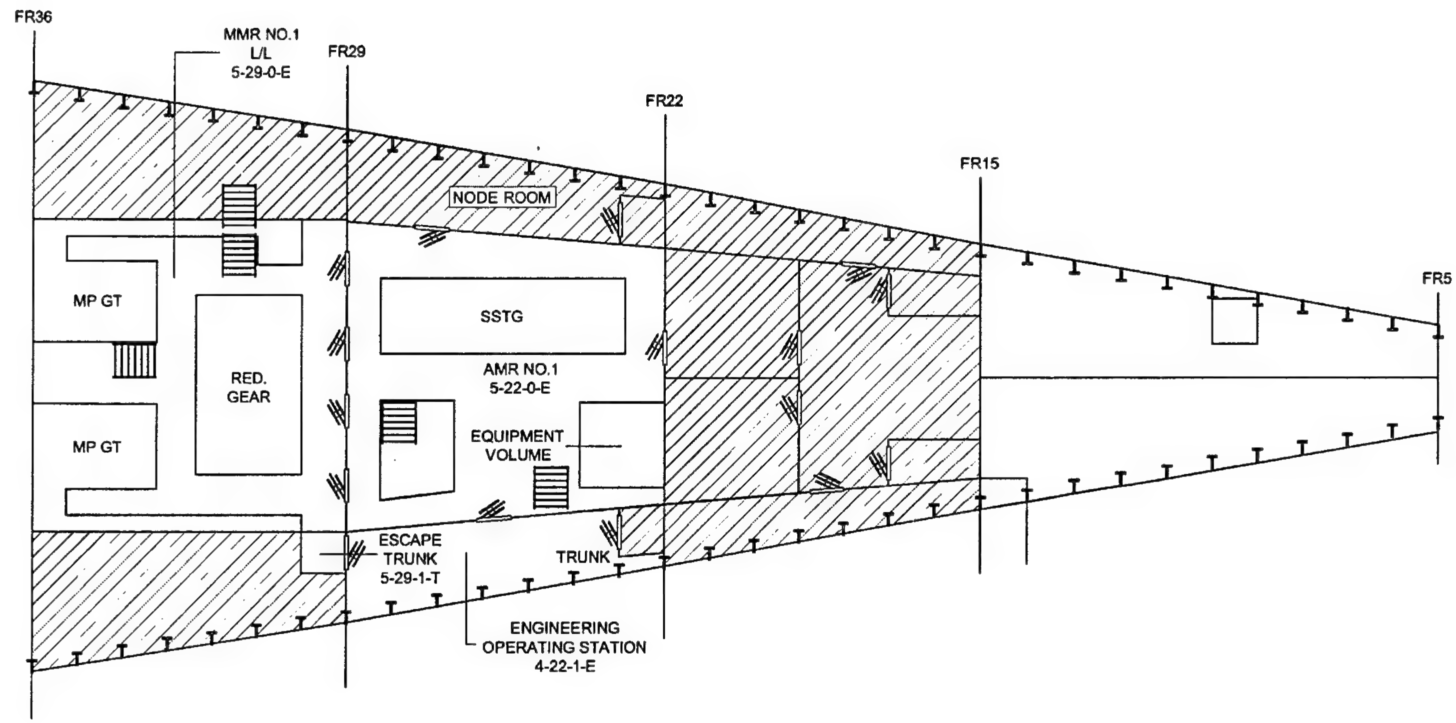


Fig. 6 - Layout of the fourth deck

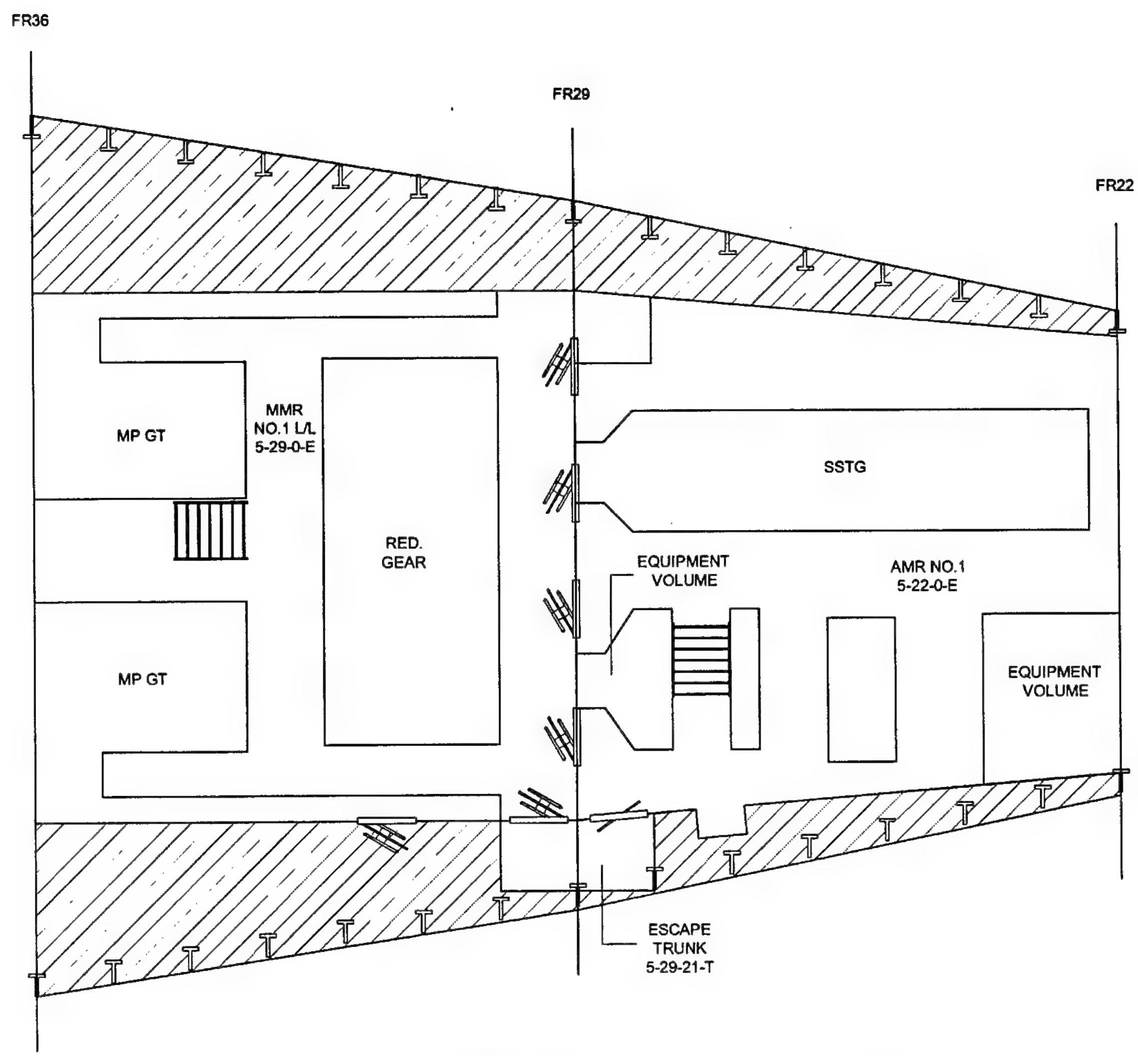


Fig. 7 - Layout of the hold level

enclosed volume is approximately 395 m^3 (13,952 ft^3). With the LM 2500 gas turbine engine mock-up occupying approximately 7% of the air space, the adjusted compartment volume becomes 370 m^3 (13,000 ft^3). The machinery space test area features upper and lower deck plate gratings with inclined ladders, an emergency escape trunk and an enclosed engineering operating control station (EOCS).

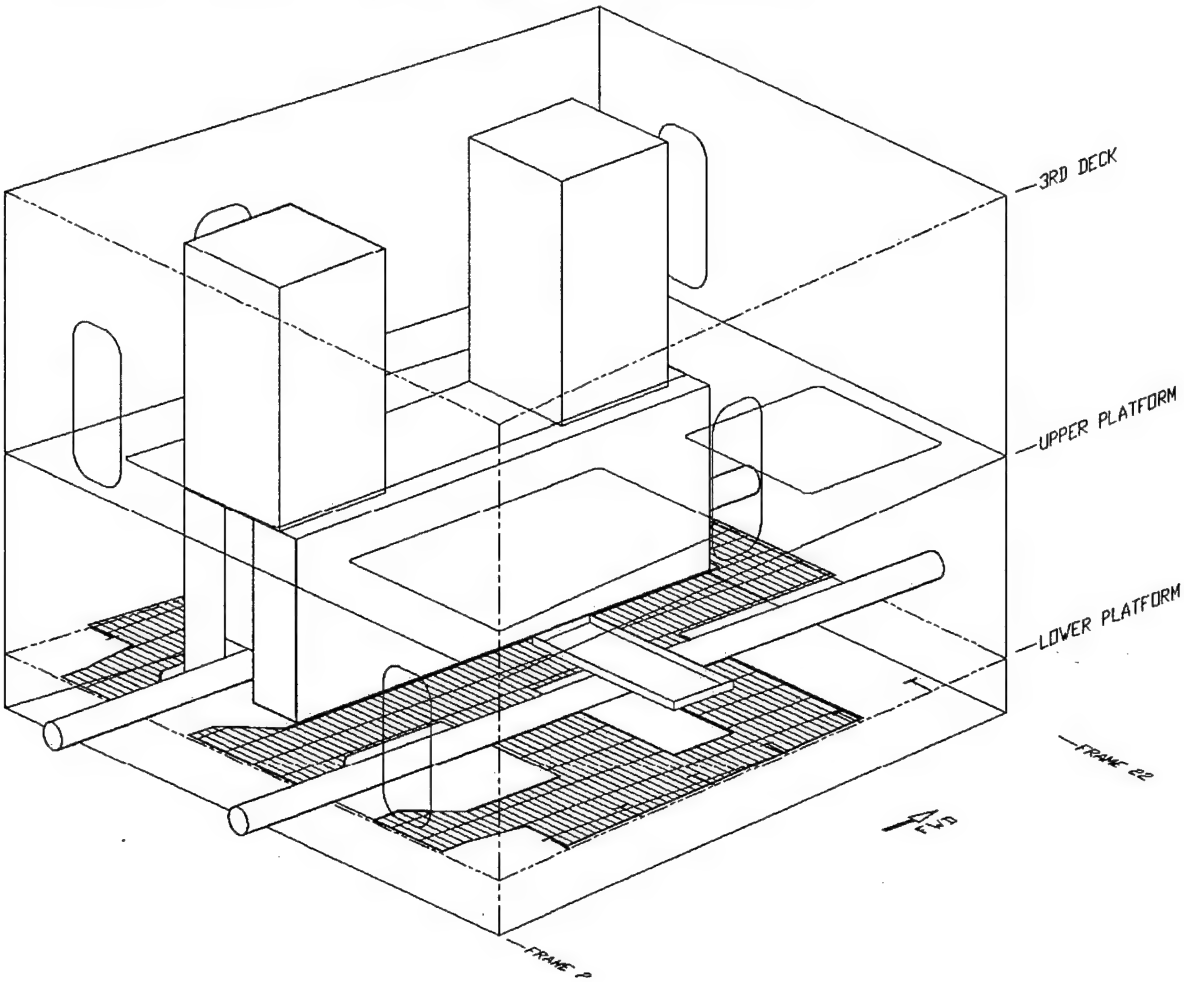


Fig. 8 – Machinery Space Test Area

3.1.4 Submarine Test Area

The Submarine Test Area, which has been classified as the SHADWELL/ 688 test area, (Fig. 9) consists of 14 spaces, excluding the Sail area, connected by watertight doors, hatches, or both. It has an available total (ventilated) volume of approximately 1194 m^3 (42,165 ft^3). This represents an approximate 17% reduction in the forward compartment of an actual 688 Class submarine. Figure 10 is a cross-section view of the SHADWELL/ 688 test area. The test area is designed such that it can be completely isolated from the surrounding spaces and the outside environment, making an airtight volume. The test area is configured such that the internal hatches, representing the normally open vertical pathways on a submarine, remain open at all times. The test area

also includes three external hatches (Fig. 10) whereby the submarine's forward compartment can be ventilated to the outside environment:

- the bridge trunk access hatch (H1),
- the weapons loading hatch (H2), and
- the forward escape trunk hatch (H3).

The Submarine Test Area also has two flood compartments that are used to study and review practical damage control procedures, such as hull repair, pipe patching, shoring and portable pump dewatering operations.

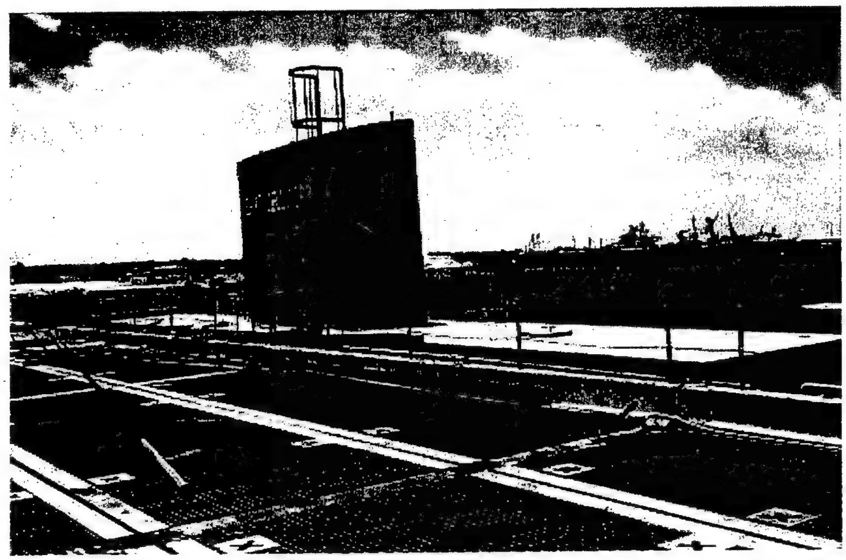


Fig. 9 – SHADWELL/ 688 Test Area

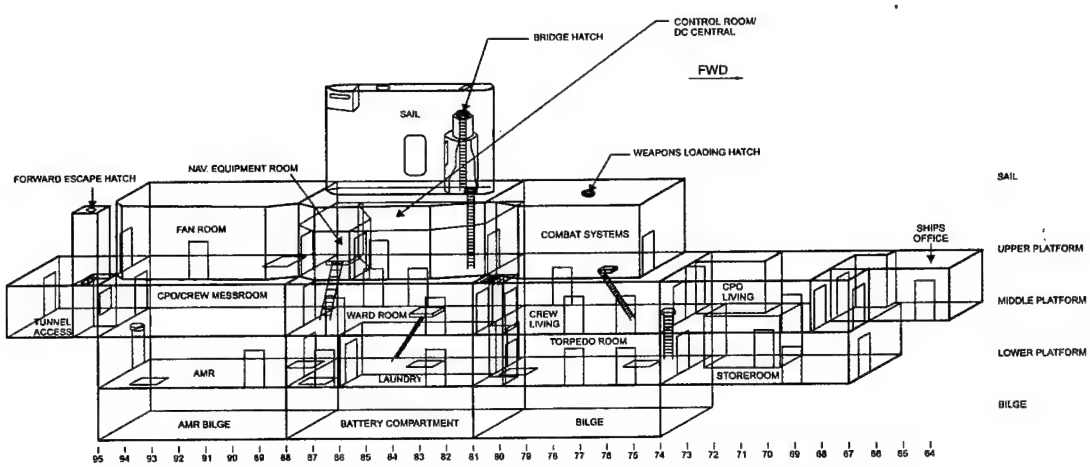


Fig. 10 – SHADWELL/ 688 Test Area

3.2 DC Systems

The ex-*USS Shadwell* is outfitted with all of the DC systems and equipment that would be expected on a modern surface combatant or submarine. The following provides an overview of the DC systems that are currently available.

3.2.1 Damage Control Repair Stations

The ex-*USS Shadwell* has three designated damage control repair stations (DCRS's). Repair 2 and Repair 3 are located in and service the forward surface ship test area and Repair 4 is located in and services the submarine test area. Each DCRS has a designated Repair Locker that is outfitted with standard U.S. Navy's DC equipment, a Wire Free Communication (WIFCOM) station, and a Damage Control System (DCS) computer work station (see Section 3.4, SHADWELL LAN). Selected DC equipment is also distributed throughout the DCRS test areas (i.e., portable smoke control equipment, portable fire extinguishers, Oxygen Breathing Apparatus (OBA's), Self-contained Breathing Apparatus (SCBA's), portable dewatering equipment, forcible entry tools and personnel protection equipment such as fire fighting ensembles (FFE's), helmets, fire fighting boots, gloves and flash gear). A DC Central (DCC) control station, which is used to receive and evaluate DC information during "active" Fleet Doctrine Evaluation (FDE) tests, is located on the port side of the 01 level between FR 47 and FR 50 (aft portion of the Crew Mess). The DCC control station is also outfitted with an intelligent Supervisory Control System (SCS) for displaying DC sensor information, pre-hit/ damage predictions, video, automated decision aids, and for automatic and remote control of various DC systems [2-3].

3.2.2 Fire Main

The ex-*USS Shadwell* fire main system consists of a 8.9-cm (3.5-in.) horizontal loop main with two electric driven fire pumps. The fire main services the distributed fireplugs located throughout the ship. A supplemental test fire main is located in the forward test area with a configuration similar to that of a DDG 51 Class ship. This fire main includes two 10.2-cm (4-in.) offset mains on the port and starboard sides of the main and 2nd decks. Cross connects are located at FR 12 and FR 23 (see Fig.11). The test fire main is outfitted with seventeen isolation valves. Eight of these valves are autonomous smart valves that enable an automated isolation response to system damage[1][4]. A LonWorks network is used to receive data from instruments and control the valves and pumps.

3.2.3 Portable Fire Fighting Equipment

Fire main related fire fighting equipment and portable extinguishers are located throughout the test areas. Fire main related fire fighting (or boundary cooling) equipment includes fire plugs, 1.9-cm (0.75-in.) hose reels, and 3.8-cm (1.5 in.) AFFF

[1] An autonomous smart valve contains onboard sensing, calculation, and communication capabilities. A smart valve can operate automatically based on conditions evaluated.

hose reels. Fire plugs (3.8-cm (1.5 in.)) are installed such that every part of the test areas can be serviced by two fire plugs using no more than 30 m (100 ft) of fire hose from each plug. The AFFF hose reels are positioned outside the 3rd deck entrance to AMR No. 1 and the hold level entrance to the escape trunk, between FR 27 and FR 28, for use in manual fire fighting activities in AMR No. 1. Portable fire extinguishers are also distributed throughout the test areas and primarily consist of CO_2, PKP and AFFF extinguishers.

3.2.4 Water Mist Suppression System

The ex-*USS Shadwell* is presently outfitted with two high-pressure (68-bar (1000 psi)) water mist suppression systems (see Fig.12). One of these systems (designated as the Machinery Space Water Mist system) was installed in AMR No.1 and MMR No. 1 as part of the developmental work for LPD 17 [5]. The second system (designated as the forward water mist system) services the forward test area on the main, 2nd and 3rd decks.

The Machinery Space water mist system consists of two zones with nozzles in the overhead of the 4th deck and hold level. The water mist system utilizes one electric driven pump that is rated for 833 lpm at 68 bar (220 gpm at 1000 psi) and is located in the ex-*Shadwell* starboard engine room, between FR 64 to 74 on the 4th deck. The system is controlled from a console in the ex-*USS Shadwell* control room or from three local control stations that are located on the 3rd deck entranceway to AMR No. 1, in the Engineering Operating Control Station (EOCS), or on lower level of the AMR escape trunk. The nozzles for the Machinery Space water mist system are an open (deluge) type, that consist of a Spraying Systems Model 7N nozzle body containing seven Model 1/4 LN orifice cap assemblies (orifice cap and orifice insert).

The forward water mist system has been constructed using the sectional loop architecture described in Reference [6]. A pump unit (consisting of multiple low flow pumps) has been installed on the 4th deck at FR 16 and is also rated at 833 lpm at 68-bar (220 gpm at 1000 psi). The pump system has the ability to adjust continuously to meet a range of flow demands. The pump unit supplies water to the mains that in turn feed branches of nozzles. An electrically actuated solenoid valve that is connected to one of the two node rooms on the 2nd deck, where a computer interface is established, controls each branch group of nozzles. As with the Machinery Space water mist system, the forward water mist system nozzles are an open (deluge) type nozzle.

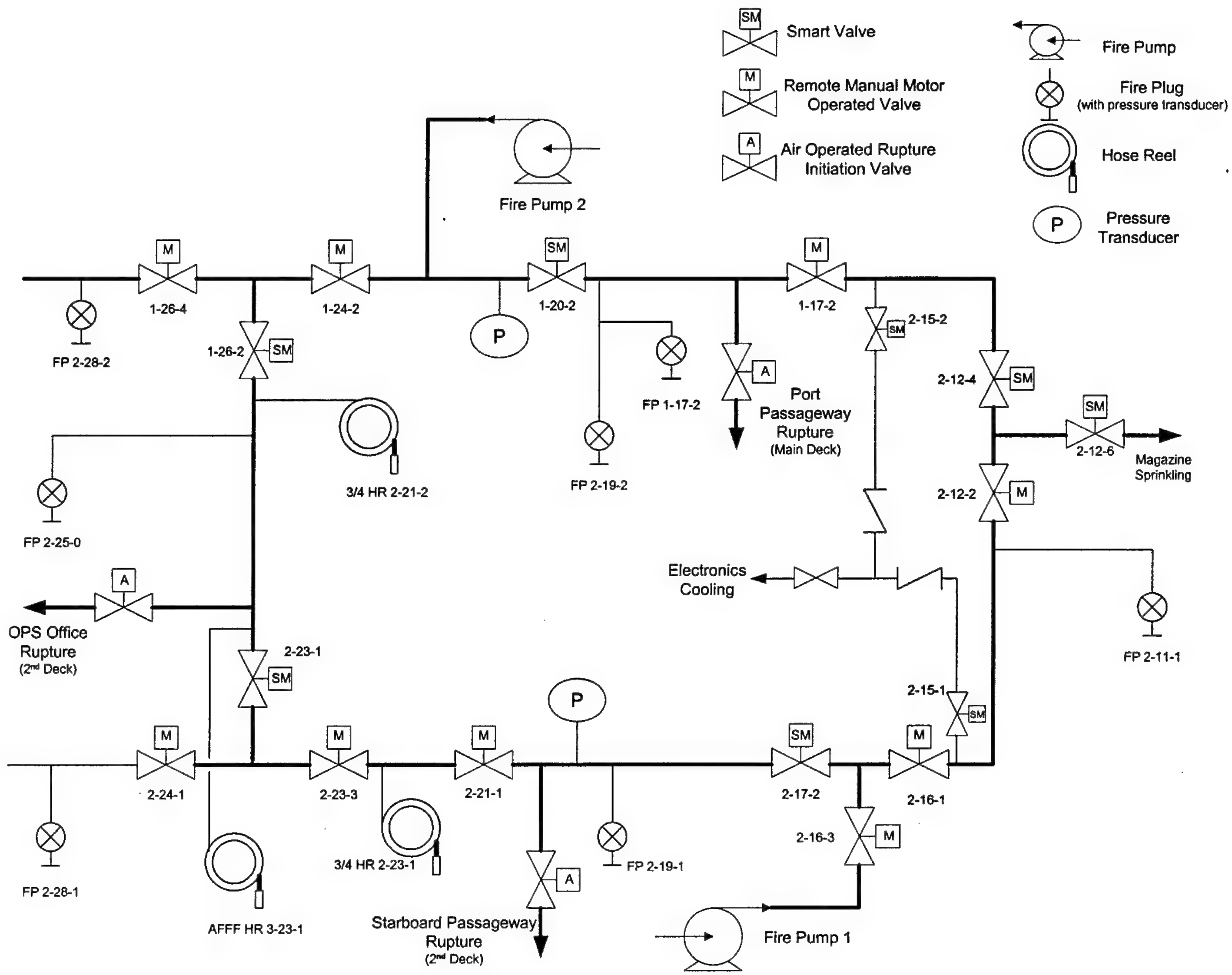


Fig. 11 - Schematic of theTest Fire Main

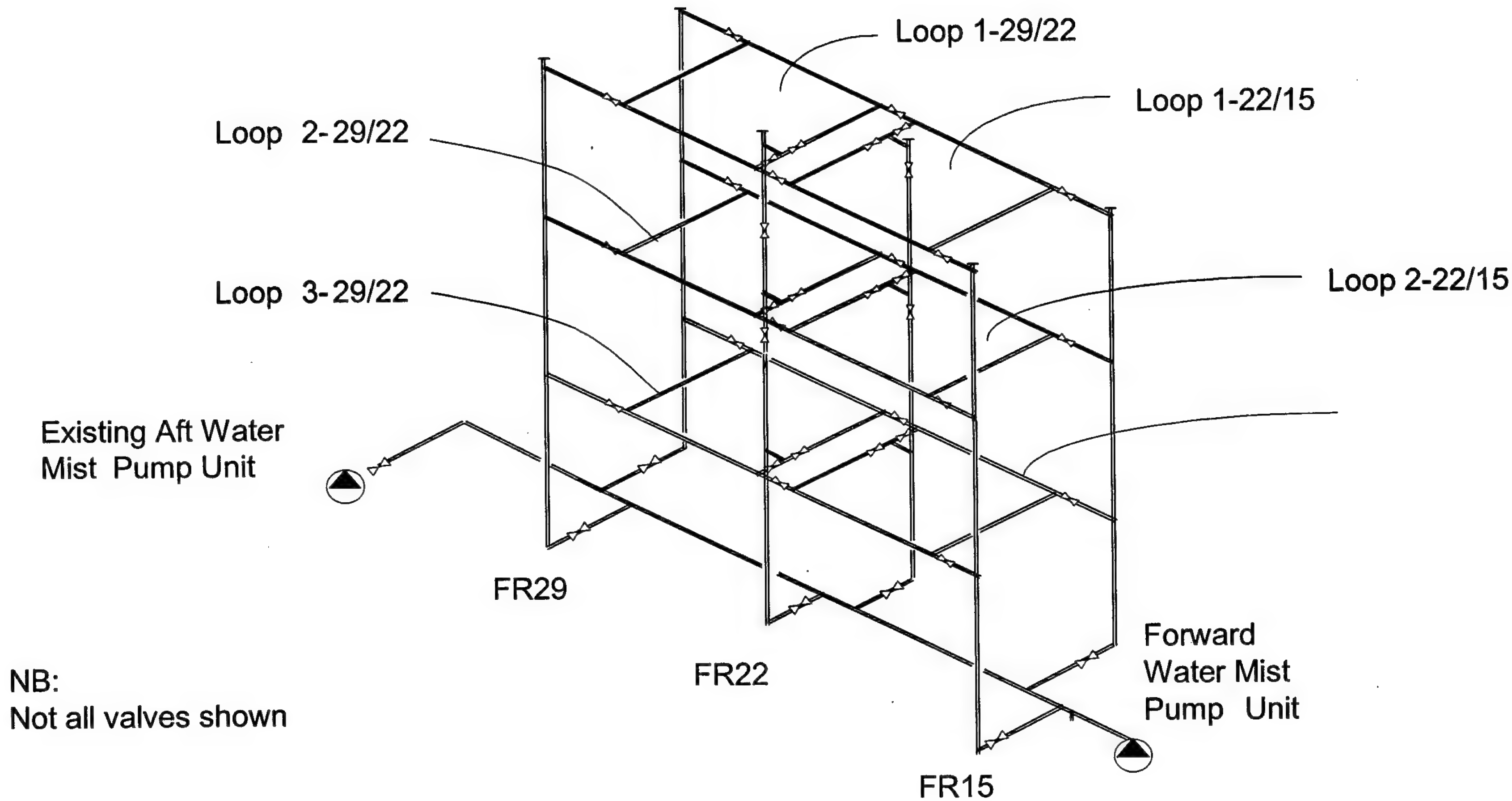


Fig 12 - Isometric view of partial sectional loop distribution system piping layout on the ex-USS SHADWELL

3.2.5 Ventilation

The ship's general heating, ventilation and air conditioning system and direct current fans provide hotel ventilation service. The direct current fans are also used for combustion air in some fire experiments. There are three additional ventilation systems that service the forward surface ship, machinery space and the submarine test areas. These ventilation systems include:

- Collective Protection System (CPS),
- Smoke Ejection System (SES), and
- SHADWELL/ 688 - Ventilation System.

3.2.5.1 Collective Protection System (CPS)

The Collective Protection System is designed to provide an overpressure of 0.5 kPa (2 in.) of water for Total Protection (TP) in the forward test area and Limited Protection (LP) in the machinery space. The TP supply and exhaust terminals are distributed throughout the forward test area. There are three supply fans (TPSS (Total Protection Supply System) 1-31-1, 1-31-2, and 01-25-2) and three exhaust fans (TPES (Total Protection Exhaust System) 1-16-1, 1-16-2, and 1-16-4). Each of the fans has two settings; on or off. The LP provides supply and exhaust ventilation to the machinery space. There is one supply fan (LPSS (Limited Protection Supply System) 1-33-2 and one exhaust fan (LPES (Limited Protection Exhaust System) 1-35-1. Each fan has three settings: high, low, and off.

3.2.5.2 Smoke Ejection System (SES)

The Smoke Ejection System (SES) consists of ductwork, automatic dampers and actuators that were added to the existing CPS. The purpose of the system is to remove smoke from the 2nd deck (DC deck) and the main deck passageways. SES terminals located in the 2nd deck passageways provide a high air change rate within the passageways to purge smoke. SES terminals in the main deck passageways are balanced such that the passageways have a pressure slightly less than in the CSMC/ Repair 8 area, thus preventing smoke filtration into that compartment. Ventilation is provided to the SES using the CPS fans. When operating in SES mode, air is diverted from the CPS terminals to the SES terminals. As a result, the CPS fans can operate in either the CPS mode or the SES mode. Data collected during tests conducted on the ex-*USS Shadwell* have demonstrated that this system is capable of restoring visibility to 6.1 m (20 ft) in the DC deck passageways in 0.5 to 5 minutes when visibility conditions were less than 1.5 m (5 ft) [7].

3.2.5.3 SHADWELL/ 688 -Ventilation System

The SHADWELL/ 688-Ventilation System is designed to simulate the submarine recirculation, induction, and low-pressure blower systems. The system includes three fans: exhaust, supply and a low-pressure (LP) blower. The exhaust fan can also be aligned as an induction fan by isolating the fan from the exhaust ducting and opening the damper to the induction ducting. The supply and exhaust fans are variable speed fans and have a maximum capacity of 11,090 l/s. The LP blower is a single speed fan with a maximum capacity of 1040 l/s.

3.3 Instrumentation

The ex-*USS Shadwell* uses a large array of sensors and instrumentation to quantify and monitor the performance of the experimental damage control systems and casualty events. The instrumentation hardware is divided into six categories, which include:

- SHADWELL Sensors,
- Door Closure Sensors,
- Early Warning Fire Detection (EWFD) System,
- COTS Fire Detection System,
- Wireless MicroLan System, and
- Video

3.3.1 SHADWELL Sensors

All fire test compartments are normally outfitted with instruments to measure temperature, smoke density (visibility), heat flux, gas concentrations and air pressure. Pressure transducers and flow meters are also used to measure various fluid systems (i.e., fire main, pressurized liquid fuel, water mist and ventilation systems).

3.3.1.1 Temperature

Type K, inconel-sheathed thermocouples, 3.2 mm (0.13-in.) outside diameter and 1.6 mm (0.06-in.) inside diameter, are used to measure air, overhead, flame and structural element temperatures.

3.3.1.2 Smoke Density

Smoke obscuration, which provides a measurement of visibility, is measured using optical density meters (ODMs). The ODMs utilize an 880 nm infrared light emitting diode (IRLED) and receptor arrangement over a 1.0 m (3.1 ft) path length [8].

3.3.1.3 Heat Flux

Total heat flux transducers (calorimeters) are used to measure total incident heat flux. The calorimeters used, typically have a range of 0-56.8 kW/m^2 (0-5 Btu/ft^2). Radiant heat flux may also be measured using radiometers that have a range of 0 to 227.2 kW/m^2 (0-20 Btu/ft^2).

3.3.1.4 Gas Concentrations

Oxygen, carbon dioxide and carbon monoxide concentrations are measured using Rosemount NGA 2000 analyzers. The gas samples are drawn continuously from the fire compartments and are filtered and passed through an impingement-type water trap. The samples also pass through cold traps to remove any remaining water.

3.3.1.5 Data Acquisition System

The MassComp (a Motorola 68020 processor) is the data acquisition system for the SHADWELL sensors and is capable of acquiring up to 400 channels of data at a sampling rate of 10 Hz and displaying these data in real time on monitors in the Control Room. Two analog/ digital converters and a tape drive are used to process and archive the data collected. The MassComp hard drive capacity is currently 1.58 GB using two 650 MB and one 2.8 MB disks. The MassComp receives data signals from the SHADWELL fiber backbone, which are made available on the SHADWELL Ethernet Network (Section 3.4, SHADWELL LAN).

3.3.2 Door Closure Sensors

Door Closure Sensors are installed in the forward test area to provide door status information. The sensor used is a variable resistance type sensor manufactured by Novotechnik (Model TR 25) [9]. The sensors indicate whether doors are open, closed but not dogged or dogged and also have a distinct output for cases where there is no signal (i.e., to indicate when the sensor or wire is damaged). Sensor information is transmitted via the SHADWELL fiber backbone and is made available on the SHADWELL Ethernet Network (Section 3.4, SHADWELL LAN).

3.3.3 Early Warning Fire Detection System

The Early Warning Fire Detector (EWFD) system is a muti-criteria device designed to improve the current fire detection capability. This improvement includes increasing detector sensitivity, decreasing the detection time and increasing the reliability through improved nuisance alarm immunity [10-11]. The sensor data are processed using a probabilistic neural network (PNN). The output of this algorithm is the probability that a fire event exists (0 to 1.0) and an alarm status flag (0= normal; 1= alarm). Data from the EWFD system are transmitted through the SHADWELL fiber backbone and are available on the SHADWELL Ethernet Network (Section 3.4, SHADWELL LAN).

3.3.4 COTS Fire Detection System

A Simplex commercial-off-the-shelf (COTS) fire detection system has been installed throughout the forward section of the ex-*USS Shadwell*. This system is composed of heat detectors, smoke (ionization and photoelectric) detectors, an alarm panel and a monitoring console in the Control Room. The detection system consists of 153 detectors. This includes 17 heat detectors, 111 photoelectric and 25 ionization smoke detectors. The system is divided into two loops. Detectors on the main deck, 01 level and 02 level are connected to loop one. Loop two connects the detectors from the 2nd deck down to the 5th deck. The system is designed and installed in accordance with NFPA 72 [12]. The COTS fire detection information is also available on the DCS work station consoles associated with the DCQ-II software only (Section 3.4, SHADWELL LAN).

3.3.5 Wireless MicroLan System

Under a Defense Advanced Research Project Agency (DARPA) program, Lucent Technologies developed the Wireless MicroLan System that allowed data received from various types of sensors (temperature and smoke) to be transmitted via radio frequency (RF) through a base station (interrogator) and WaveLAN node point to a control and monitoring station. The system currently has 19 temperature and smoke detectors that are located on the main and 2nd deck between FR 9 through FR 29. The Wireless MicroLan system also includes a mobile personnel monitor capable of transmitting body condition (i.e., heart rate, surface temperature, sweat rate and motion) and approximates the location of the wearer.

3.3.6 Video

Visual cameras are located throughout the test areas to provide camera images to the Control Room and to record test images on video recorders. The cameras also provide visualization information to the SCS system located in DCC. The video system consists of 36 cameras that are connected to one of ten Indigo Model VP 400 Video Codec's. The Video Codec's are used to digitize the video images and transmit the video packages via the SHADWELL fiber backbone to a network/ video work station in the Control Room. The video signals are then made available on the SHADWELL Ethernet Network (Section 3.4, SHADWELL LAN) [13].

3.4 SHADWELL LAN

The SHADWELL LAN consists of three subnets that are interconnected (see Fig. 13) [13]. These subnets include

- SHADWELL fiber backbone,
- SHADWELL_NT network, and
- Damage Control System (DCS) network.

3.4.1 SHADWELL Fiber Backbone

The SHADWELL Fiber Backbone consists of an optical fiber plant (system backbone), routing distribution equipment that manages ethernet data between 10 Node Rooms and a network and video management PC located in the Control Room (Node Room # 1). The backbone of this system operates at Gigabit speeds and handles large volumes of standard (10 Mbps) and fast (100 Mbps) ethernet data with an RJ45 interface. The FutureFlex Air Blown fiber cable plant was constructed using a 7-tube backbone connected through 10 tube distribution units (TDUs). Each TDU is installed in or near the 10 Node Rooms. Switching and distribution hardware is installed in the Node Rooms to form the ethernet backbone and to route data on the system.

3.4.2 SHADWELL_NT Subnet

The SHADWELL_NT subnet is a thinnet, 10 Base-2/ Base 10/100 (Coax and RJ45 interfaces) LAN. It supports the Control Room, adjacent areas and DCC. Network TCP/IP addresses and work group names are administered by SHADWELL personnel and reside on the MassComp.

3.4.3 DCS Subnet

The Damage Control System (DCS) subnet consists of 7 Windows NT Pentium III (1 GHz) work stations that can be used to display damage control alarms, plotting, timing and monitoring resource allocations. The DCS subnet is a Fiber Optic Passive-Star LAN. It supports the DCAMS, DC system and DCQ information programs.

3.5 Support Service

3.5.1 Weight Handling

The ex-*USS Shadwell* has a 9-ton crane and a forklift to facilitate weight handling requirements. The crane is a hydraulic powered, Alaska Marine crane (Model MCT-956) that features variable capacity/ angle and a telescoping boom. The maximum capacity of the crane is 18,000 lb (two part rigging) and 1,460 lb (single part rigging). The forklift is a diesel powered Windham Power Lifts forklift that has a maximum lift capacity of 6000 lb.

3.5.2 Electrical Power

The principal source of electrical power is “shore power”, 3 phase, 460 V, 800A at the source. The electrical distribution system services 460V for electrical motors and machinery and 208/120V for lighting and other AC equipment uses. The electrical distribution system also provides 230 VDC and 120 VDC for direct current applications.

NETWORK SCHEME

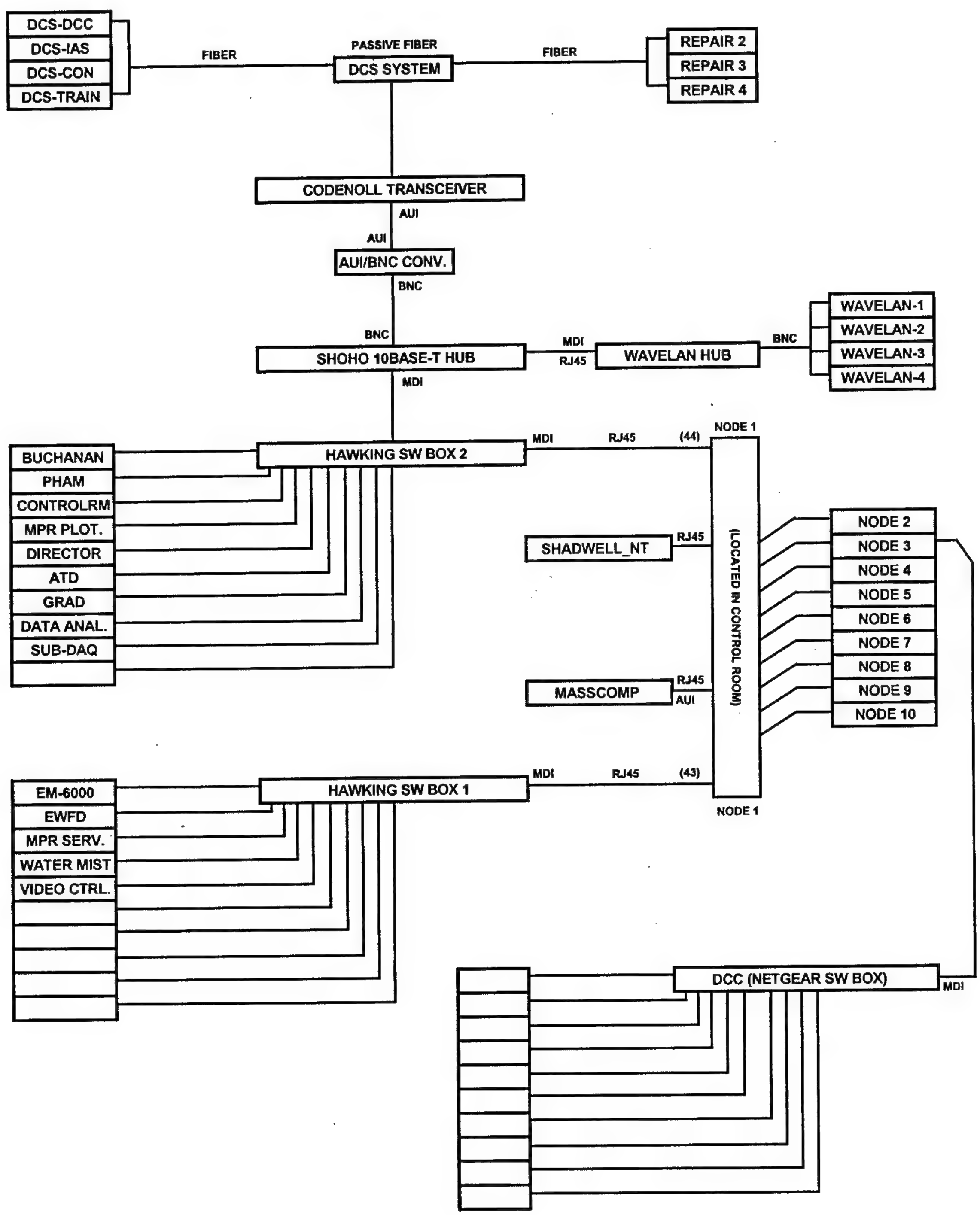


Fig. 13 - SHADWELL Ethernet LAN's

KCM
August 2, 2001

Two emergency diesel generators provide emergency electrical power. The emergency diesel generators are rated at 400kW/ 600A and 215kW/ 400A. Emergency lighting (battle lanterns) are also distributed throughout the test facility.

3.5.3 Air Systems

The ex-*USS Shadwell* has a low-pressure air system with one electric driven low-pressure air compressor (LPAC) and a high-pressure air system with two electric driven high-pressure air compressors (HPAC). The LPAC system is rated at 175 psi (maximum) and is used to support ship service air requirements. The HPAC system is rated at 3000 psi and is used to provide breathing air for the ship's SCBA.

3.5.4 Small Boats

Small boats are available to transport personnel and equipment to and from the ex-*USS Shadwell* test facility. The small boats include:

- 40 ft Boat – The MK6 is the primary boat to transport test participants and visitors to the ex-*USS Shadwell*. It is constructed of single-skin GRP, has a round bottom hull and is powered by a single diesel engine. The cargo capacity of the boat is 40 personnel – 7200 lb.

- 35 ft Boat - The 35-ft general-purpose boat is primarily used to transport SHADWELL personnel and equipment. It has an aluminum hull and is powered by two VOLVO, 200 hp diesel engines with out drives. The 35-ft boat is all weather capable and has a cargo capacity of 35 personnel.

- 10 ft Boat – The 10-ft boat is an aluminum hull boat powered by a 25 hp, gasoline outboard engine. It is restricted to operations around the ship and has a cargo capacity of 3 personnel.

4.0 CURRENT/ PLANNED PROGRAMS

There are currently six programs that are either on going or planned for future DC RDT&E studies. These programs include:

- Passive Fire Program (PFP),
- Submarine Fire Safety Improvement Program,
- Halon Replacement Program,
- Damage Control – Automation for Reduced Manning (DC-ARM),

- Advanced Damage Countermeasures (ADC), and
- DD-21 Damage Control Procedures/ Doctrine Development Program

4.1 Passive Fire Program (PFP)

The Passive Fire Program (PFP) is an on-going program designed to study the flammability and fuel loading of shipboard materials and to develop modeling techniques to predict fire performance which can be used in fire hazard and ship vulnerability analysis. The PFP program is aimed at reducing the potential fuel load aboard surface ships and submarines. The program includes fire risk studies related to working fluids, paints and coatings, insulation, cabling, composites, clothing and habitability furnishings. The PFP program has also developed mathematical models to predict fire behavior and interactions of materials and assessed the potential for small-scale fire tests to predict real scale fire performance.

4.2 Submarine Fire Safety Improvement Program

The Submarine Fire Safety Improvement Program is an on-going program designed to test and evaluate new technologies and procedures for submarine fire fighting. The program is specifically aimed at developing "quick response" methodologies that will limit fire and smoke spread on board submarines. The program provides recommendations and technical guidance to the Naval Sea System Command (NAVSEA 05L4), and helps maintain the Naval Ships' Technical Manual (NSTM) Chapter 555 – Volume 2, "Submarine Firefighting".

4.3 Halon Replacement Program

The Halon Replacement Program is an on-going program aimed at developing replacement agents and alternatives to Halon. The program has included laboratory-scaled screening of candidate agents, intermediate scaled chamber tests and full-scale shipboard discharge tests. The program has focused on identifying a suitable halon-like (vaporizing liquid) substitute and developing water mist technologies. The program has identified HFC-227ea (CF_3-CHFC-CF_3; or FM-200^{TM}) and high-pressure water mist (68 bar (1000 psi)) as the best "halon-free" fire protection options for future Navy ships [14-15].

4.4 Damage Control – Automation for Reduced Manning (DC-ARM)

The Damage Control – Automation for Reduced Manning (DC-ARM) program is an on-going program that has been designed to develop the technologies necessary to achieve major reductions in DC manning. The DC-ARM program has focused on developing the technologies for automating shipboard damage assessment and casualty responses to shipboard fire and fluid system damage conditions. The program is divided into four program elements that include reflexive fluid system technologies (smart valves), advanced fire detection technology, a zonal water mist/ smoke control system and intelligent Supervisory Control System (SCS) technologies (see Fig. 14).

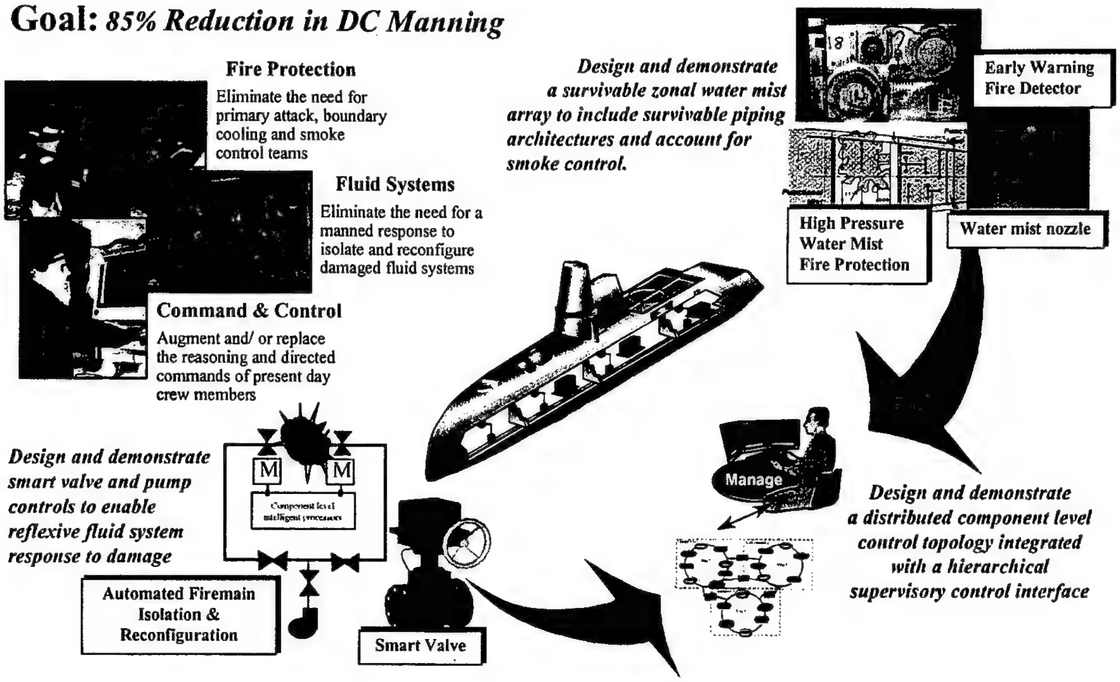


Fig. 14 – DC-ARM Program Overview

4.5 Advanced Damage Countermeasures (ADC)

The Advanced Damage Countermeasures (ADC) is a new program that is part of ONR's Platform Protection, Future Naval Capabilities (FNC) program. The ADC program is currently planned for FY 02-05 and will continue to build on the DC-ARM concepts and further expand automated damage control system capabilities. The program is divided into four independent research efforts that include; the development of an advanced volume sensor, the development of an automated hull damage & stability monitoring system, the development of high efficiency water mist for electronic space protection and the introduction of a water-based blast mitigation system (see Fig. 15).

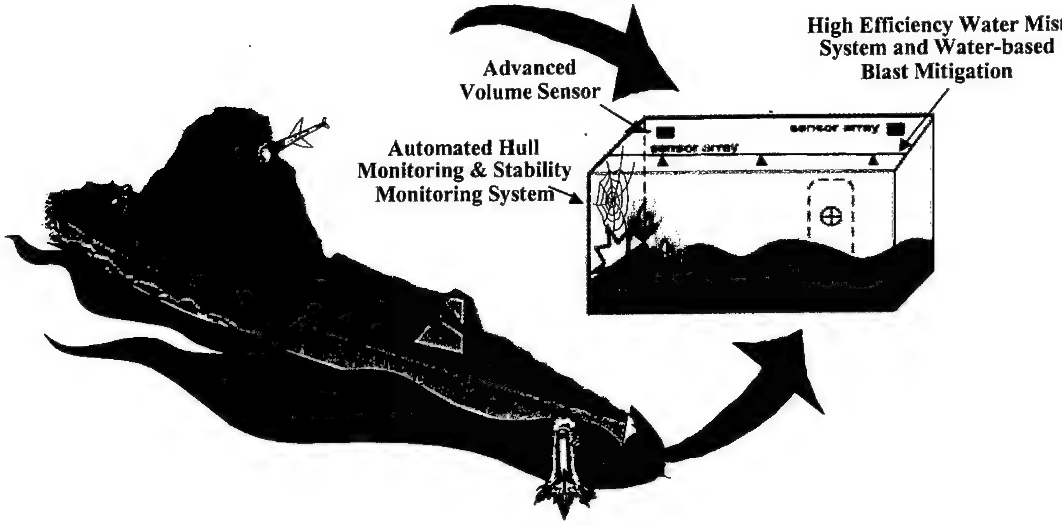


Fig. 15 – ADC Program Overview

4.6 DD-21 Damage Control Procedures/ Doctrine Development Program

The DD-21 Damage Control Procedures/ Doctrine Development program is a new program that is intended to build on the previously sponsored Chief of Naval Operations (OPNAV) Integrated Survivability Fleet Evaluation (ISFE) program and conduct Fleet evaluations of advanced DD 21 DC concepts under realistic shipboard casualty conditions. The program objectives are to:

- Ensure DD 21 recoverability performance objectives can be met with established manning levels and systems;
- Develop the Navy's doctrine and procedures for using new DC systems, focusing on system development and command & control; and
- Identify unique DC shipboard, land-based and classroom training approaches and potential requirements.

This program is currently planned for execution in FY 05-09 and is intended to support NAVSEA (PMS 500) and the DD 21 Industry Team. As with the ISFE program, this effort will also provide recommendations and technical guidance to NAVSEA (05L4) for maintaining and updating the requisite technical publications, such as NSTM 555, Volume 1, "Surface Ship Firefighting", and NSTM 079, Volume 2, "Practical Damage Control".

5.0 REFERENCES

1. Janssens, M.L., "Measuring Rate of Heat Release by Oxygen Consumption," *Fire Technology*, August 1991, p. 234.

2. Bradley, M., Burns, S., Downs, R., Lestina, T., Roberts, M., Runnerstrom, E., Yufik, Y., Sheridan T., Tatem, P.A., Williams, F.W., "Damage Control – Automation for Reduced Manning/ Supervisory Control System Development – Phase I," NRL Memorandum Report NRL/MR/6180-00-8468 of June 26, 2000.

3. Stover, J.A., Barr, R.R., Bruhn, P.L., Lang, S., Williams, F.W., "Shipboard Damage Control – Automation for Reduced Manning (DC-ARM) – Intelligent Controller-Part 2," NRL Memorandum Report NRL/MR/6180-00-8460 of May 29, 2000.

4. Lestina, T., Bradley, M., Downs, R., Runnerstrom, E., Farley, J., Durkin, A., and Williams, F.W., "Development of DC-ARM Reflexive Smart Valave," NRL Memorandum Report NRL/MR/6180-01-8552 of May 7, 2001.

5. Back, G.G., DiNenno, R.L., Darwin, R.L., Hill, S.A., Havlovick, B.J., Toomey, T.A. Farley, J.P., Hill, J.M., and Williams, F.W., "Full-scale Machinery Space Water Mist Tests: Final Design Validation," NRL Memorandum Report, NRL/MR/6180-99-8380, of June 12, 1999.

6. Mawhinney, J.R., DiNenno, P.J., and Williams, F.W., "New Concepts for Design of an Automated Hydraulic Piping Network for a Water Mist Fire Protection System on Navy Ships," NRL Ltr Report 6180/0292, of July 18, 2000.

7. Peatross, M.J., Pham, H.V., Scheffey, J.L., Farley, J.P., Lestina, T., Smith, S., Toomey, T.A., and Williams, F.W., "Results of LPD-17 Smoke Control/ Machinery Space Fire Fleet Doctrine Evaluations Exercises," NRL Ltr Report 6180/0620, of October 22, 1999.

8. TSI Incorporated, "Final Report Smoke Detector, IRLED," prepared for David Taylor Naval Ship R&D Center, January 1988.

9. Mai, M.T., and Robertson, R., "Conceptual Evaluation of Two Voltage Resistance-Based Closure Sensors," NRL Ltr Report 6180/0066, of April 26, 2000.

10. Rose-Pehrsson, S.L., Hart, S.J., Shaffer, R.E., Gottuk, D.T., Wright, M.T., Wong, J.T., Street, T.T., Tatem, P.A., and Williams, F.W., "Analysis of Multi-Criteria Fire Detection Prototype Selection," NRL Memorandum Report, NRL/MR/6110-00-8484, of September 18, 2000.

11. Rose-Pehrsson, S.L., Hart, S.J., Hammind, M.H., Gottuk, D.T., Wright, M.T., Wong, J.T., Street, T.T., Tatem, P.A., and Williams, F.W., "Real-Time Probabilistic Network Performance and Optimization for Fire Detection and Nuisance Alarm Rejection: Test Series 2 Results," NRL Memorandum Report, NRL/MR/6110-00-8499, of October 10, 2000.

12. NFPA 72, "National Fire Alarm Code," 1996 Edition, National Fire Protection Association, Quincy, MA., 1996.

13. Street, T.T., Bailey, J., Tate, D., Riddle, T., and Williams, F.W., "Upgrades to Data Capabilities on ex-USS SHADWELL," NRL Ltr Report 6180/0229, of May 26, 2000.

14. Maranghides, A., Sheinson, R.S., "Selection of a Higher Concentration for LPD-17 Main and Auxiliary Machinery Rooms Total Flooding Fire Suppression Systems," NRL Ltr Report 6180/0249, of May 5, 1995.

15. Back, G.G., DiNenno, P.L., Leonard, J.T., and Darwin, R.L., "Full Scale Tests of Water Mist Fire Suppression Systems for Navy Shipboard Machinery Spaces: Part II – Obstructed Spaces," NRL Memorandum Report, NRL/MR/6180-96-7831, of March 8, 1996.

Appendix A

Joint Research Agreement

U.S. Department of Transportation
United States Coast Guard

Commandant
United States Coast Guard

Washington, DC 20593
Staff Symbol: C-DMT-3/54
Phone: (202) 426-1023

3308.8/0673U

23 SEP 1985

From: Commandant
To: Commander, Naval Sea Systems Command

Subj: UNITED STATES COAST GUARD/UNITED STATES NAVY JOINT RESEARCH AGREEMENT - MARINE FIRE HAZARD RESEARCH

Ref: (a) COMNAVSEA ltr 9930 Ser: 55X2/257 15 Aug 85

1. Enclosed is a signed original of the subject agreement. The cooperative efforts toward establishment of this agreement were commendable.

2. We look forward to the accomplishment of the objectives of the agreement, and an increase of Coast Guard participation in the Navy Passive Fire Safety program.

R. M. POLANT
Acting Chief, Office of Research and Development

Encl: (1) UNITED STATES COAST GUARD/UNITED STATES NAVY JOINT RESEARCH AGREEMENT - Marine Fire Hazard Research, 17 September 1985

UNITED STATES COAST GUARD/UNITED STATES NAVY

JOINT RESEARCH AGREEMENT

Marine Fire Hazard Research

1. Authority

This Joint Research Agreement (JRA) is entered into as a Memorandum of Understanding between the United States Coast Guard (USCG) and the United States Navy (USN) concerning cooperation in Research, Development, Testing and Evaluation (RDT&E) of shipboard fire protection.

2. Overall Objective

The overall objective of the JRA is to increase the effectiveness of the USCG and the USN research programs in fire protection through expansion of the USCG fire and Safety Test Detachment (F&STD) in Mobile, Alabama, and to include joint research projects, information exchange, and program coordination in the use of this facility.

3. Methods of Cooperation

3.1 General: The following methods of cooperation will be utilized under this JRA:

3.1a The USN will supplement the F&STD facility at Little Sand Island, Mobile, Alabama by incorporating a retired surface combatant as a third test ship next to the existing ships. The USN will be responsible for site preparation, including dredging in order to provide berthing for the USN ship. The USN test ship will be assigned to the Naval Research Laboratory (NRL). The environmental impact statement currently in effect for the USCG test ships will be amended by the USN to include the USN test ship.

3.1b The USN will have primary cognizance over its own ship in planning and performing tests, but will closely coordinate all testing with the USCG Research and Development Center, Groton, Connecticut. The overall F&STD complex will be under the control of the USCG.

3.1c Both parties will exchange operational and assessment data and participate in the definitional phase of experimental facility planning.

3.1d Both parties will exchange reports embodying significant research results from their activities subject to restrictions on distribution of proprietary or other sensitive data. No classified data will be handled at the site.

3.1e Researchers from both agencies will participate in workshops and conferences by the USCG or the USN to address specific marine fire protection issues and to provide a mechanism for the formal/informal exchange of information.

3.1f Both parties will cooperate in studies to evaluate the benefits and cost of potential applications for marine fire protection research.

3.1g Researchers from both agencies will be invited to inspect experimental test facilities and to witness and/or participate in tests related to marine fire protection.

3.1h Both parties will exchange any developed software packages for studying the performance and operation of fire protection devices or methods.

4. Project Officers

4.1 Designation:

FOR U.S. NAVY

Primary Project Officer:	Technical Project Officer:
Director, Fire Protection Division Naval Sea Systems Command Washington, D. C.	Head, Combustion Section Naval Research Laboratory Washington, D. C.

FOR U.S. COAST GUARD

Primary Project Officer:	Technical Project Officer:
Chief, Marine Technology Division, Office of Research and Development Washington, D. C.	Chief, Marine Fire Research Branch, USCG Research and Development Center Groton, CT

4.2 Responsibilities - The Primary Project Officers will be responsible for general administration and informing their respective agencies of accomplishments and the overall effectiveness of this JRA. The Technical Project Officers will be responsible for achievement of objectives of this JRA and will be the principal point of interface between the parties. An on-scene test director, for each test series, will be designated by letter from the USCG Technical Project Officer and so specified in each test plan.

4.3 Coordination Meetings - Coordination meetings will be held at least annually to familiarize the Primary Project Officers with the status of activities. The meetings will be held alternately at NRL and R&DC.

4.4 Reporting - The Technical Project Officers will prepare a joint annual report to the Chief, Office of Research and Development; Commander, Naval Sea Systems Command; and the Chief of Naval Research reporting the results of meetings and progress achieved.

5. Financial Arrangements

5.1 The USCG will charge to the USN the full cost for use by the USN of the F&STD including, but not limited to the use of USCG test ships, USCG personnel or USCG equipment and associated facilities except as indicated in paragraph 5.3.

5.2 The USN will charge to the USCG the full cost for use by the USCG of the USN test ship, USN personnel or USN equipment except as indicated in 5.3.

5.3 For test projects of mutual benefit to the USCG and the USN, cost sharing will be proportioned to each in an amount equal to the benefit received as agreed to in advance. Either party has the option to withdraw from a project if funds are not available, provided that on-going task sharing or cost sharing projects will be completed in accordance with original terms and schedules.

5.4 Funds shall be transferred sufficiently in advance of testing to permit the timely purchase of all supplies and materials necessary to conduct the tests.

6. Disclosure of Information

Both parties will make clear to all manufacturers cooperating with any specific agenda item that all information provided at the review meetings will become publicly available, except to the extent that either party requests that the information not be made available to the public; and to the extent that withholdiing such information is consistent with public law.

7. Liability

7.1 Facilities - Tests plans will be mutually agreed to for the safety of personnel and equipment. The on-scene test director will conduct all tests and may terminate any test for technical reasons. A safety observer will be assigned by the supervisor of F&STD for each test series. The safety observer may terminate any test for significant safety reasons. NRL through the USN Technical Project Officer will be responsible for the USN test ship and ancillary equipment except where overall safety of the general facility is concerned. Any placement or removal of equipment on the USN ship must have prior approval of NRL, in addition to approval of the supervisor of F&STD. The overall safety of the F&STD facility resides with the USCG.

7.2 Technical Data - The parties will make a best effort to ensure the accuracy of all data, but the accuracy of such data is not guranteed. Each party will use the other's data at its own risk and may not hold the other party responsible in the event of claims arising out of the use of said data.

7.3 Navy Ship Disposition - It is anticipated that after ten years, use of the USN ship as a test platform will end. In the event that disposition includes removal from the berthing site as described in paragraph 3.1a, said removal will be at no cost to the USCG. Any monies derived from disposition of the USN ship will be under the cognizance of the Chief of Naval Operations.

8. Duration of Agreement

This agreement shall enter into force upon signature and remain in force until terminated by either party upon written notification, provided that on-going task sharing or cost sharing will be completed in accordance with their original agreed terms and schedules.

9. Amendments

This JRA may be amended at any time by mutual agreement in writing.

AGREED:

FOR THE UNITED STATES NAVY

M. V. Ricketts

RADM M. V. RICKETTS
Deputy Commander
For Ship Design and
Engineering
Naval Sea Systems Command

Date 14 August 1985

J.B. Mooney

RADM J.B. MOONEY, JR.
Chief of Naval Research

Date 8·26·85

FOR THE UNITED STATES COAST GUARD

H. B. Thorsen

COMO H. B. THORSEN, Chief
Office of Research and Development

Date 17 Sept 1985